COLORADO GEOLOGICAL SURVEY
DEPT. OF NATURAL RESOURCES

GEOLOGY FOR LAND-USE PLANNING IN THE GREEN MOUNTAIN RESERVOIR AREA, SUMMIT COUNTY, COLORADO

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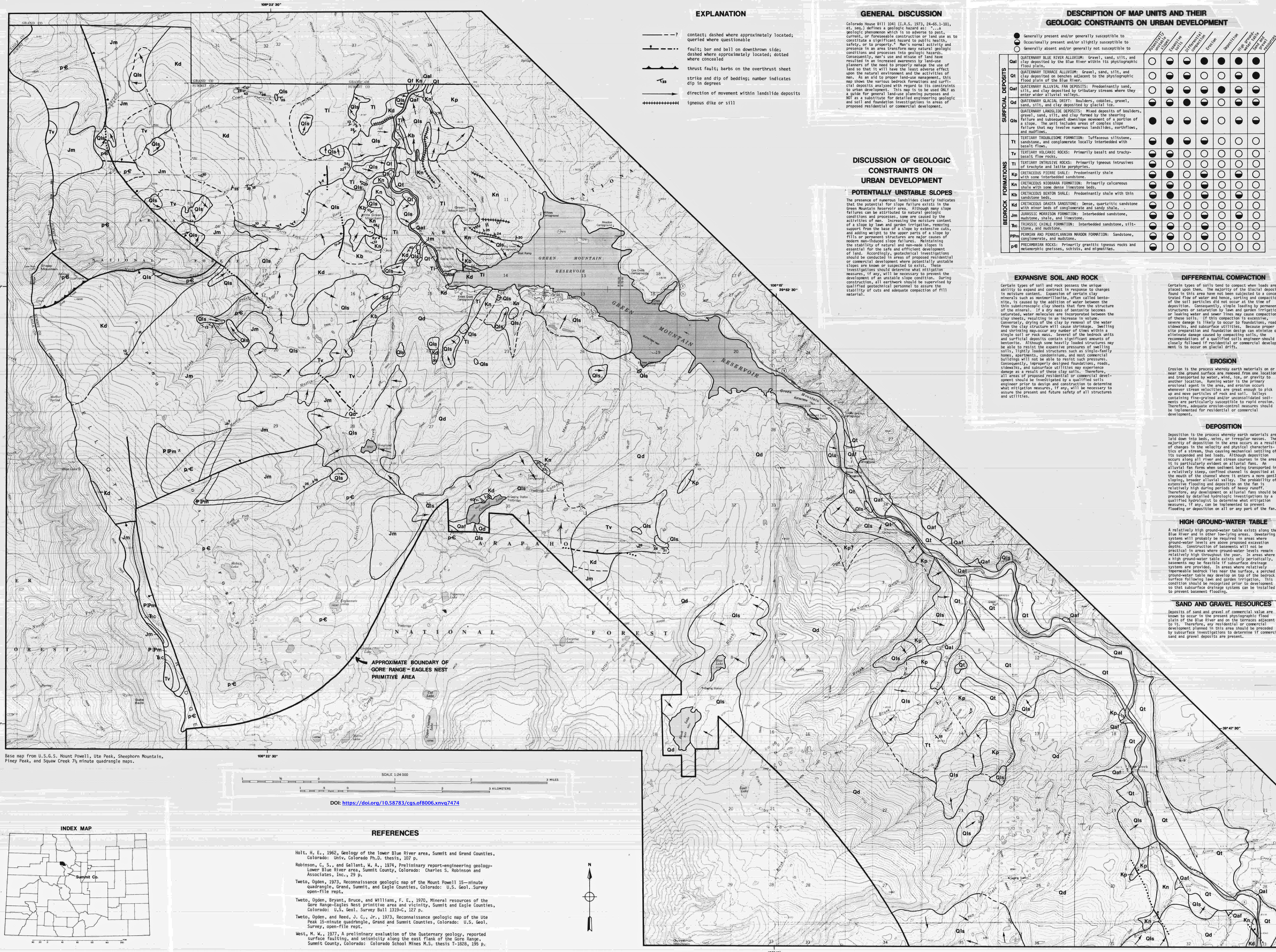
by JAMES N. PRICE



Base map from U.S.G.S. Mount Powell, Ute Peak, Sheephorn Mountain, Piney Peak, and Squaw Creek 7½ minute quadrangle maps.

SCALE 1:24 000

1 ½ 0 1 2 3 MILES

1 .5 0 1 2 3 KILOMETERS

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EXPLANATION

contact; dashed where approximately located; queried where questionable

fault; bar and ball on downthrown side; dashed where approximately located; dotted where concealed

thrust fault; barbs on the overthrust sheet

strike and dip of bedding; number indicates dip in degrees

direction of movement within landslide deposits

igneous dike or sill

GENERAL DISCUSSION

Colorado House Bill 1041 (C.R.S. 1973, 24-65.1-101, et. seq.) defines a geologic hazard as: "...a geologic phenomenon which is so adverse to past, current, or foreseeable construction or land use as to constitute a significant hazard to public health, safety, or to property." Man's normal activity and presence in an area transform many natural geologic conditions and processes into geologic hazards. Consequently, man's use and misuse of land have resulted in an increased awareness by land-use planners of the need to properly manage the use of land so that it will have the least adverse effect upon the natural environment and the activities of man. As an aid to proper land-use management, this map shows the various bedrock formations and surficial deposits analyzed with regard to its constraints to urban development. This map is to be used ONLY as a guide for general land-use planning purposes and NOT as a substitute for detailed engineering geologic and soil and foundation investigations in areas of proposed residential or commercial development.

DESCRIPTION OF MAP UNITS AND THEIR GEOLOGIC CONSTRAINTS ON URBAN DEVELOPMENT

● Generally present and/or generally susceptible to
◒ Occasionally present and/or slightly susceptible to
○ Generally absent and/or generally not susceptible to

			Potentially unstable slopes	Expansive soils	Differential compaction	Erosion	Deposition	High ground-water table	Sand and gravel resources
SURFICIAL DEPOSITS	Qal	QUATERNARY BLUE RIVER ALLUVIUM: Gravel, sand, silt, and clay deposited by the Blue River within its physiographic flood plain.	○	◒	◒	●	●	●	●
	Qt	QUATERNARY TERRACE ALLUVIUM: Gravel, sand, silt, and clay deposited on benches adjacent to the physiographic flood plain of the Blue River.	○	◒	◒	○	○	◒	●
	Qaf	QUATERNARY ALLUVIAL FAN DEPOSITS: Predominantly sand, silt, and clay deposited by tributary streams where they enter wider alluvial valleys.	○	◒	◒	◒	●	◒	◒
	Qd	QUATERNARY GLACIAL DRIFT: Boulders, cobbles, gravel, sand, silt, and clay deposited by glacial ice.	◒	◒	●	◒	○	◒	◒
	Qls	QUATERNARY LANDSLIDE DEPOSITS: Mixed deposits of boulders, gravel, sand, silt, and clay formed by the shearing failure and subsequent downslope movement of a portion of a slope. The unit includes areas of complex slope failure that may involve numerous landslides, earthflows, and mudflows.	●	◒	◒	◒	○	◒	◒
BEDROCK FORMATIONS	Tt	TERTIARY TROUBLESOME FORMATION: Tuffaceous siltstone, sandstone, and conglomerate locally interbedded with basalt flows.	◒	●	◒	◒	○	○	○
	Tv	TERTIARY VOLCANIC ROCKS: Primarily basalt and trachybasalt flow rocks.	◒	◒	○	○	○	○	○
	Ti	TERTIARY INTRUSIVE ROCKS: Primarily igneous intrusives of trachyte and latite porphyries.	◒	○	○	○	○	○	○
	Kp	CRETACEOUS PIERRE SHALE: Predominantly shale with some interbedded sandstone.	◒	●	○	◒	○	◒	○
	Kn	CRETACEOUS NIOBRARA FORMATION: Primarily calcareous shale with some dense limestone beds.	◒	◒	○	◒	○	○	○
	Kb	CRETACEOUS BENTON SHALE: Predominantly shale with thin sandstone beds.	◒	●	○	◒	○	◒	○
	Kd	CRETACEOUS DAKOTA SANDSTONE: Dense, quartzitic sandstone with minor beds of conglomerate and sandy shale.	◒	○	○	○	○	○	○
	Jm	JURASSIC MORRISON FORMATION: Interbedded sandstone, mudstone, shale, and limestone.	◒	◒	○	◒	○	◒	○
	₸c	TRIASSIC CHINLE FORMATION: Interbedded sandstone, siltstone, and mudstone.	◒	◒	○	◒	○	○	○
	PIPm	PERMIAN AND PENNSYLVANIAN MAROON FORMATION: Sandstone, conglomerate, and mudstone.	◒	◒	○	◒	○	○	○
	p€	PRECAMBRIAN ROCKS: Primarily granitic igneous rocks and metamorphic gneisses, schists, and migmatites.	◒	○	○	○	○	○	○

DISCUSSION OF GEOLOGIC CONSTRAINTS ON URBAN DEVELOPMENT

POTENTIALLY UNSTABLE SLOPES

The presence of numerous landslides clearly indicates that the potential for slope failure exists in the Green Mountain Reservoir area. Although many slope failures can be attributed to natural geologic conditions and processes, some are caused by the activities of man. Increasing the moisture content of a slope by lawn and garden irrigation, removing support from the base of a slope by extensive cuts, and adding weight to the upper parts of a slope by fills or permanent structures are major causes of modern man-induced slope failures. Maintaining the stability of natural and man-made slopes is essential for the safe and efficient development of land. Accordingly, geotechnical investigations should be conducted in areas of proposed residential or commercial development where potentially unstable slopes are known or suspected to exist. These investigations should determine what mitigation measures, if any, will be necessary to prevent the development of an unstable slope condition. During construction, all earthwork should be supervised by qualified geotechnical personnel to assure the stability of cuts and adequate compaction of fill material.

EXPANSIVE SOIL AND ROCK

Certain types of soil and rock possess the unique ability to expand and contract in response to changes in moisture content. Expansion of certain clay minerals such as montmorillonite, often called bentonite, is caused by the addition of water between the thin submicroscopic clay sheets that form the structure of the mineral. If a dry mass of bentonite becomes saturated, water molecules are incorporated between the clay sheets, resulting in an increase in volume. Conversely, drying of the clay by removal of the water from the clay structure will cause shrinkage. Swelling and shrinking may occur any number of times within a single soil or rock mass. Several of the bedrock units and surficial deposits contain significant amounts of bentonite. Although some heavily loaded structures may be able to resist the expansive pressures of swelling soils, lightly loaded structures such as single-family homes, apartments, condominiums, and most commercial buildings will not be able to resist such pressures. Consequently, improperly designed foundations, roads, sidewalks, and subsurface utilities may experience damage as a result of these clay soils. Therefore, all areas of proposed residential or commercial development should be investigated by a qualified soils engineer prior to design and construction to determine what mitigation measures, if any, will be necessary to assure the present and future safety of all structures and utilities.

DIFFERENTIAL COMPACTION

Certain types of soils tend to compact when loads are placed upon them. The majority of the Glacial deposits found in this area have not been subjected to a concentrated flow of water and hence, sorting and compaction of the soil particles did not occur at the time of deposition. Consequently, simple loading by permanent structures or saturation by lawn and garden irrigation or leaking water and sewer lines may cause compaction of these soils. If this compaction is excessive, severe damage is likely to occur to foundations, roads, sidewalks, and subsurface utilities. Because proper site preparation and foundation design can minimize or eliminate damage caused by compacting soils, the recommendations of a qualified soils engineer should be closely followed if residential or commercial development is to occur on glacial drift.

EROSION

Erosion is the process whereby earth materials on or near the ground surface are removed from one location and transported by water, wind, ice, or gravity to another location. Running water is the primary erosional agent in the area, and erosion occurs whenever stream velocities are great enough to pick up and move particles of rock and soil. Valleys containing fine-grained and/or unconsolidated sediments are particularly susceptible to rapid erosion. Therefore, adequate erosion-control measures should be implemented for residential or commercial development.

DEPOSITION

Deposition is the process whereby earth materials are laid down into beds, veins, or irregular masses. The majority of deposition in the area occurs as a result of changes in the velocity and physical characteristics of a stream, thus causing mechanical settling of its suspended and bed loads. Although deposition occurs along all river and stream courses in the area, it is particularly evident on alluvial fans. An alluvial fan forms when sediment being transported in a relatively steep, confined channel is deposited at the mouth of the channel where it enters a more gently sloping, broader alluvial valley. The probability of extensive flooding and deposition on the fan is relatively high during periods of heavy runoff. Therefore, any development on alluvial fans should be preceded by detailed hydrologic investigations by a qualified hydrologist to determine what mitigation measures, if any, can be implemented to prevent flooding or deposition on all or any part of the fan.

HIGH GROUND-WATER TABLE

A relatively high ground-water table exists along the Blue River and in other low-lying areas. Dewatering systems will probably be required in areas where ground-water levels are above proposed excavation depths. Construction of basements will not be practical in areas where ground-water levels remain relatively high throughout the year. In areas where a high ground-water table exists only periodically, basements may be feasible if subsurface drainage systems are provided. In areas where relatively impermeable bedrock lies near the surface, a perched ground-water table may develop on top of the bedrock surface following lawn and garden irrigation. This condition should be recognized prior to development so that subsurface drainage systems can be installed to prevent basement flooding.

SAND AND GRAVEL RESOURCES

Deposits of sand and gravel of commercial value are known to occur in the present physiographic flood plain of the Blue River and on the terraces adjacent to it. Therefore, any residential or commercial development planned in this area should be preceded by subsurface investigations to determine if commercial sand and gravel deposits are present.

INDEX MAP

Summit Co.

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